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(56) Documents Cited

WO 93/02340 A1

US 4630245 A

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(54) Interchangeable vessel having a liquid level sensor

(57) An interchangeable vessel 2 containing a substance and constructed to be inserted into apparatus which uses the substance, comprises a tank 4 formed of acoustically conductive material and a piezo electric film element 12 affixed to the outer surface of the vessel and serving as a level sensor for the substance contained in the tank of the vessel. The piezo electric film element 12 includes electrical contacts 24,26 interconnected to active signal and ground electrodes 14-22 formed as part of the piezo electric film element, with contact pads 24,26 constructed so as to be electrically coupled with electronics contained within the apparatus for driving the piezo electric element, when the vessel is inserted into the apparatus.

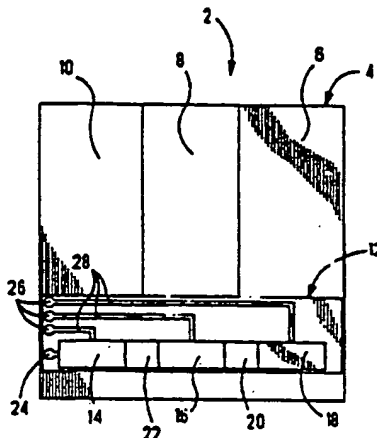


Fig. 1

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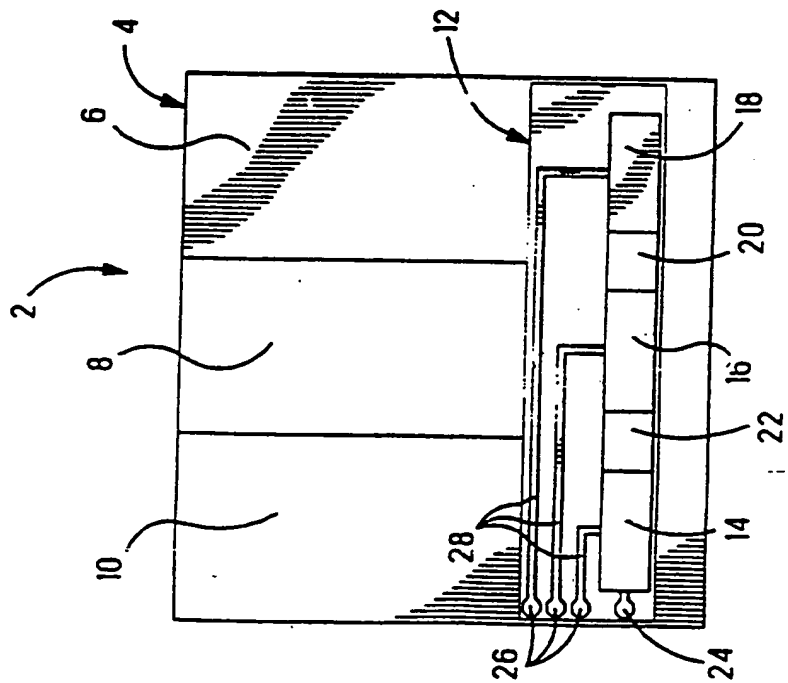


Fig. 1

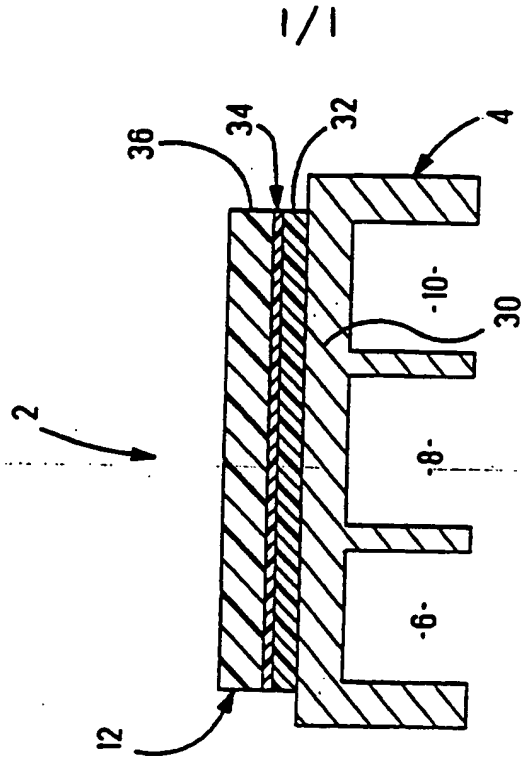


Fig. 2

INTERCHANGEABLE VESSEL HAVING A LEVEL SENSOR THEREWITH

This invention relates to vessels for holding a liquid therein that are interchangeable within a larger apparatus and where the liquid level therein must be  
5 monitored.

There are many modern apparatus that utilize liquid contained within an interchangeable vessel in their function. One example would be a modern computer printer. These devices typically include a disposable ink cartridge  
10 that contains the ink used to perform the printing operation. It is advantageous if it could be determined when the level of these cartridges is getting low. With typical black ink, the ink contains sufficient carbon that it is known to use an electrical current to determine  
15 whether or not a certain level of fluid remains within a cartridge. A problem has arisen with respect to the new colour printers in that the coloured ink used therein does not have sufficient carbon to provide an adequate electrical signal path. Mechanical apparatus is also  
20 known to measure liquid level and typically involves a float coupled to a mechanical switch or potentiometer connected thereto. A problem with these devices is that they must be in physical contact with the fluid within the cartridge and therefore take up space therein. In  
25 addition, mechanical structure such as this would be relatively expensive even in the high qualities that are envisioned for interchangeable cartridges such as these. It would be difficult for a user to recycle the mechanical apparatus due to the associated mess involved in  
30 interchanging the devices between the old and replacement cartridges. It is also known to use ultrasonic measuring of liquid levels by measuring the time required for an acoustic signal to travel across a portion of the cartridge where the ink would be disposed. As such  
35 systems have no moving parts, they have good

reliability; however, most are relatively complex and expensive which is a major drawback when dealing with a vessel that must be interchangeable and may in fact be disposable.

5 It is further known by way of U.K. Patent Application No. 9613553.8 entitled "Liquid Level Switch" to incorporate the benefits of acoustic liquid level measuring without some of the associated problems. In this application a sensor that is fixable upon an outer  
10 surface of a tank wall is disclosed. The operating concept involves sending an acoustic pulse through the tank wall and detecting the characteristics of a reflection that would be caused by the tank wall air interface versus the tank wall liquid interface.  
15 Therefore, it is desired to incorporate this technology into an interchangeable vessel that would be easy to use and economical in form.

These and other objects are accomplished by providing an interchangeable vessel for receiving a substance  
20 therein where the vessel is constructed to be inserted into a larger apparatus so that the apparatus may use the substance therein, the interchangeable vessel comprising a tank formed of acoustically conductive material and a piezo electric film element affixed to the outer surface  
25 of the vessel; where the piezo electric film element includes electrical contacts interconnected to an active signal electrode and a ground electrode that are formed as part of the piezo electric film level sensor; where contact pads of the electrodes are constructed to be  
30 electrically coupled with electronics contained within the apparatus for driving the piezo electric element.

Advantageously, the interchangeable vessel is provided with a sensing element that is economical and easy to use. It is a further advantage of this invention that the  
35 device may be made disposable.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a side view of an interchangeable vessel incorporating a level sensor thereupon according to the present invention; and

Figure 2 is a cross sectional view of a portion of vessel of Figure 1.

With reference now to Figure 1, a vessel according to the present invention is shown generally at 2. This vessel 2 includes a tank portion 4 having three reservoirs 6,8,10 therein, each for holding a substance therein. In this embodiment, the tank 4 is generally rectangular in shape. It should be noted that the tank could take on any desired shape and may include multiple reservoirs as shown in Figure 1, or only a single reservoir. Disposed across the tank 4, towards the bottom thereof, is a piezo electric film element 12.

The piezo electric film element 12 includes a metallized portion that is made up of three active signal electrodes 14,16,18 that are respectively separated by ground planes 20,22. The ground function of this apparatus is electrically coupled through to a ground contact pad 24. Furthermore, each of the active signal electrodes 14,16,18 is connected to signal contact pads 26 that are interconnected by way of circuit traces 28.

With reference now to Figure 2, a cross-section of the vessel 2 is shown. The tank 4 is shown having an outer wall 30 upon which the piezo electric element 12 is affixed. The piezo electric element 12 is bonded thereto by an acoustically transparent adhesive 32. The actual piezo film 34 is metallized, and is laminated between the adhesive 32 and possibly a polyester laminant 36. The polyester laminant 36 would obviously be formed in such a way that the signal contacts 26 and the ground contact 24 are accessible therefrom as all the electrical contacts

-4-

would be desirably made along the outer surface. The inter-connection with the driving circuitry within the main apparatus (not shown) could occur by way of spring metal contacts. The interchangeable vessel 2 is inserted  
5 into the apparatus to form a wiping interconnection with the spring metal contacts or the insulating/conductive rubber alternating structure that is typically used to connect LCD displays.

The foregoing is simply an example and other  
10 desirable connections may be realized. In the simplest form, the device is intended to measure when the last few millimeters of ink are remaining and then convert this into a user friendly form, such as a visual display. The driving circuitry is well known and explained in the  
15 afore-mentioned application that is being incorporated by reference. The circuitry can run on a single five volt supply and draws only a few milliamps when running. If it is further desired to minimize the current draw, the measurement may be made at specific intervals as opposed  
20 to continuously.

It would also be possible to manufacture the piezo-electric sensor element 12 in a continuous manner so that high speed and high volume manufacture may be realized. This would involve fabricating the structure on a  
25 continuous basis and possibly supply the product on long rolls similar to labelling systems. In addition, the outer polyester surface 36 could also act as a carrier so that typical label printing could be disposed thereupon. This would enable the entire assembly to look like a label  
30 disposed upon a tank. As it is also envisioned that the wiping interconnection would occur as the device is being seated within the apparatus, there is no need for additional actions in order to affect the electrical interconnections.

CLAIMS

1. An interchangeable vessel for receiving a substance therein and which is constructed so as to be insertable into apparatus which uses the substance, the interchangeable vessel  
5 comprising a tank formed of acoustically conductive material and a piezo electric film element affixed to an outer wall of the vessel, said piezo electric film element including electrical contacts interconnected with at least one active signal electrode for transmitting and/or receiving an acoustic  
10 signal and at least one ground electrode formed as part of the piezo electric film element, said contacts being constructed so as to be electrically connectable with electronics contained within the apparatus for driving the piezo electric film element.
- 15 2. The interchangeable vessel of claim 1, wherein the tank includes multiple reservoirs and the piezo electric film element includes active signal electrodes associated with the reservoirs.
- 20 3. A piezo electric film element for measuring fluid levels in an interchangeable vessel formed of an acoustically conductive material, the piezo electric film element comprising at least one active signal electrode for transmitting and/or receiving an acoustic signal and at least  
25 one ground electrode, the ground and signal electrodes having contact pads connected thereto to form an interface therewith, and the film element being affixable to an outer wall of the vessel.
- 30 4. The piezo electric film element of claim 3, wherein the film element includes an adhesive layer for bonding the film element to the vessel.
5. The piezo electric film element of claim 4, wherein opposite the adhesive layer a laminate layer is overlaid.
6. The piezo electric film element of claim 3, 4 or 5, including multiple active signal electrodes.

7. The piezo electric film element of claim 3, 4, 5 or 6, wherein the contact pads are exposed at or adjacent one end of the element.
- 5 8. A piezo electric film element for measuring fluid levels in an interchangeable vessel of acoustically conductive material, constructed substantially as hereinbefore described with reference to the accompanying drawings.
- 10 9. An interchangeable vessel containing a substance and which is insertable into apparatus which uses the substance, constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.



# Patent Office

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Application No: GB 9618527.7  
Claims searched: 1-9

Examiner: Matthew Nelson  
Date of search: 2 December 1996

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.O): G1G ( GPL )

Int CI (Ed.6): G01F ( 23/28, 23/296 )

Other: Online:- WPI

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	WO 93/02340 A1 (ATOCHEM). See figure 1, page 2 line 31 - page 3, line 7 and page 3, lines 27-33.	1, 3 & 6
X	US 4630245 (DAM). See figure 1, and col 3, lines 13-25.	1, 3 & 4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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